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(54) **MOS-TYPE SOLID-STATE IMAGING APPARATUS AND IMAGE PICKUP METHOD THEREFOR**

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a MOS-type solid-state imaging apparatus which can make the length of signal accumulation period and the accumulation start time of a light receiving element to be the same in whole pixels and in which the distortion of an image is not generated even if a moving object is taken in as a still imagewhich has an electronic shutter and which prevents the constitution of the pixel from becoming complicated and to provide the image pickup method.
SOLUTION: In a MOS-type solid-state imaging apparatusmultiple pixels having light receiving elements generating and outputting signals by photoelectric conversionMOS transistors for amplificationwhich amplify the signalsand MOS transistors for switchwhich are installed between the light receiving elements and the MOS transistors for amplificationare arranged in a matrix shape. A resetting MOS transistor which is connected to the output parts of the light receiving elements are resets the output parts of the light receiving elements is installed.

CLAIMS

[Claim(s)]
[Claim 1]A photo detector which generates a signal by photoelectric conversion and is outputtedand a MOS

transistor for amplification which amplifies the signalIn an MOS type solid state camera which arranged two or more pixels which have said photo detector and the MOS transistor for a switch provided between said MOS transistors for amplification to matrix formAn MOS type solid state camera providing a MOS transistor for reset which was connected to an outputting part of said photo detectorand which makes an outputting part of said photo detector constant potential with reset.

[Claim 2]A photo detector which generates a signal by photoelectric conversion and is outputtedand a MOS transistor for amplification which amplifies the signalIn an MOS type solid state camera which arranged two or more pixels which have said photo detector and the MOS transistor for a switch provided between said MOS transistors for amplification to matrix formand constituted a picture element partA substrate of the 1st conduction typeand the 1st field of the 2nd conduction type formed into this substrateBy having the 2nd field of the 1st conduction type formed all over this 1st fieldproviding an opening without said 1st field under said 2nd fieldconstituting said photo detector from said 1st field and said 2nd fieldand changing potential of said 1st fieldAn MOS type solid state camera having a transistor which resets an output of said photo detector which makes said 2nd field an outputting part.

[Claim 3]It is an imaging method of the MOS type solid state camera according to claim 1 or 2Set simultaneously an output of said photo detector of said all the pixels as predetermined potentialand lightwave signal accumulation by said photo detector is startedAfter inputting simultaneously an output of said photo detector of said all the pixels into said transistor for amplification and holding it after specified time elapsean output of said photo detector is outputted from said transistor for amplification one by one for every line of said picture element partAn imaging method of an MOS type solid state camera performing lightwave signal accumulation of all the pixels during the same period simultaneous.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention is concerned with a solid state camera and an imaging method for the sameand

relates to an amplified type MOS type solid state camera without image distortion in particularand a method for the same.

[0002]

[Description of the Prior Art]In recent yearsas a solid state image pickup devicelow power consumption and the ease of peripheral circuit unification attract attentionand the amplified type MOS type solid state camera is developed briskly. Hereafterthe outline of an MOS type solid state image pickup device is explained with an attachment explanatory view side. Drawing 6 is an outline block diagram of the MOS type solid state camera of a conventional example. As shown in drawing 6outline composition of the MOS type solid state camera 30 (only henceforth an imaging device) is carried out from the peripheral circuit which controls the picture element part 22 which performs photoelectric conversionand this picture element part 22and performs signal processing.

[0003]The picture element part 22 comprises the pixel 12 located in a line with the matrix form of the predetermined number beside vertical (henceforth a sequence) (henceforth a line). Each control line (only henceforth TGRGand RS) of TG lineRG lineand RS line is connected to these pixels 12 from the row control circuit 24 for controlling these for every line.

In order to control these for every sequenceeach control line (only henceforth SHS and SHR) of the SHS line and the SHR line is connected from the row control circuit 5.

[0004]the digital disposal circuit 7 where the photoelectric conversion signal acquired from the picture element part 22 is connected with the picture element part 22 -- noise rejection -- an AD translation is carried out and it is outputted. The row control circuit 24 and the row control circuit 5 are connected to the address control circuit 23. The address control circuit 23 is connected to the data control circuit 6. The digital disposal circuit 7 is connected to the level address selection circuits 8 and the data control circuit 6.

[0005]Drawing 7 is a block diagram showing the pixel in the MOS type solid state camera of a conventional example. Since explanation of the signal processing part 20 in the digital disposal circuit 7 connected to this with the pixel 12 surrounded and shown with a dashed line is easyit is shown in drawing 7. In drawing 7G shows a gateS shows a source and D shows a drainrespectively. The pixel 12 comprises:

Four MOS transistors M1M2M3.
M4 (following).
And it only says M1M2M3and M4it is photo detector PD (following).
It is also only called PD.

[0006]The P side of PD is grounded and the N side is connected to the source of M2. TG is connected to the gate of M2the drain of M2 is connected to the source of M1and the gate of M3and these form node SF. RG is connected to the gate of M1 and the drain of M1 is connected to the reference voltage line 15. The predetermined voltage VDD is impressed to the reference voltage line 15. The drain of M3 is connected to the reference voltage line 15and the source of M3 is connected to the source of M4.
[0007]The gate of M4 is connected to RS and the output from the pixel 12 is outputted from the drain of M4. The drain of M4 is inputted into the signal processing part 20and is connected to each source of the drain of MOS transistor M5 (M5 is only said hereafter)and MOS transistors M6 and M7 (M6 and M7 are only said below) through the node OUT. The gate of M5 is connected to the reference voltage line 16predetermined voltage VB is given to predetermined timingand the source of M5 is grounded.
[0008]The gate of M6 is connected to SHS and the drain of M6 is connected to the end of capacity CSand the plus (+) end of differential-amplifier DA (only henceforth DA).
The other end of capacity CS is grounded.
The gate of M7 is connected to SHR and the drain of M7 is connected to the end of capacity CRand the minus (-) end of DA.
The other end of capacity CR is grounded.

[0009]Nextsignal extraction from the conventional pixel 12 is explained. Drawing 8 is a figure showing the timing of the control signal in the MOS type solid state camera of a conventional example. Drawing 8 is referred to for a control signal. Although the control signal over the pixel of the 1st line and the pixel of the 2nd line in the picture element part 22 is shown in drawing 8 as an exampleit is the same also to other lines. A horizontal axis shows time. Firstthe output from all the pixels 12 of the 1st line in the picture element part 22 is sent to the digital disposal circuit 7 at party part coincidenceAfter reading 1 pixel at a time from the left after that and outputting nextfurthermore it sent the output from all the pixels 12 of the 2nd line to the digital disposal circuit

7this was repeated and applied to the pixel 12 of the lower line in orderand the signal of the 1 field was read.
[0010]Although the following explanation is explanation about one pixeloperation with all the same pixels that constitute each line is performed. RG first connected to the pixel 12 of the 1st line is made into high potentialand node SF is set to the voltage VDD by considering M1 as one. M4 will be turned onif RS is made into high potential after making RG into low voltage and making M1 off. Since fixed voltage VB has hung on the gate of M5 and constant current flowsa source follower circuit is constituted from M3-M4-M5and the voltage V1 which is 1 (potential of VDD) (threshold voltage of M3) appears in the node OUT. Thenif SHR is made into high potentialand capacity CR will be charged by V1. [M7]
[0011]Nextafter making SHR into low voltage and making M7 offif TG is made into high potentialand the potential of node SF will change in proportion to the potential of photo detector PD. [M2] And the voltage V2 of (potential proportional to potential of PD) - (threshold voltage of M3) appears in the node OUT. Thenif SHS is made into high potentialand capacity CS will be charged by V2. [M6] Since the capacity CS and CR has led to each input of differential amplifier DAthe voltage of (V2-V1)i.e.the voltage of (voltage proportional to potential of PD) - (potential of VDD)is obtained as the output.
[0012]By the read method of the output signal from such a pixelthe output which is not related to the size of the threshold voltage of M3 and dispersion of the threshold voltage of M3 in each pixel is obtained. After making SHS and RS into low voltage after making SHS into high potential between predetermined timeand turning OFF M6 and M4only predetermined time makes RG and TG high potential simultaneouslymakes M1 and M2 oneand sets the nodes SF and PD (the output side of a photo detector is also hereafter called PD) to the potential of VDD. Since TG serves as low voltage and M2 is come by off after PD is set to VDDthe lightwave signal generated by the light which entered into PD after it is accumulated in PD. The period when a lightwave signal is accumulated in PD of this pixel is after PD is set to VDD until TG becomes high potential by the signal read operation of the same line in the next field.
[0013]After signal read-out to the pixel 12 of the 1st line finishessignal read-out to the following pixel 12 of the 2nd line is performed like the case of the 1st lineas mentioned above (see the timing diagram of the 2nd line of

drawing 8). Like the 1st linethe lightwave signal storage period of the pixel of the 2nd line is after signal read-out of this pixel finishes and PD is set to VDD until TG becomes high potential by read-out of the next field.
[0014]
[Problem to be solved by the invention]By the wayalthough length is the samethe gap will have produced the lightwave signal storage period of the pixel of the 1st lineand the pixel of the 2nd line at time of onset. For exampleif the line of a pixel reads the pixel of each line once one by one in those with 500and 1/30 secondin up-and-down 1 spacingthe time of onset of lightwave signal accumulation will have a difference only for 1/30 second for 1/15000 second at the 1st line and the 500th line.
[0015]The difference in this lightwave signal storage start time is seldom worriedwhen the photographic subject which is moving is picturized and people see as an animationbut when some animations are incorporated as Still Picture Sub-Division and image display is carried outfaultlike an outline is distorted arises. Especially this makes difficult application of the MOS type solid state camera to the digital camera only for Still Picture Sub-Division.
[0016]Thenin [this invention solves an aforementioned problem and] an MOS type solid state cameraIt enables it to make the same the length and its storage start time of a signal storage period of a photo detector by all the pixelsAlso when incorporating the photographic subject which moves by this as Still Picture Sub-Divisionand it does not produce distortion of a pictureit has electronic shutter functions and aims at providing an MOS type solid state camera which moreover does not complicate composition of a pixeland an imaging method for the same.
[0017]
[Means for solving problem]As a means for attaining the above-mentioned purposethe MOS type solid state camera of this invention by Claim 1The photo detector which generates a signal by photoelectric conversion and is outputtedand the MOS transistor for amplification which amplifies the signalIn the MOS type solid state camera which arranged two or more pixels which have said photo detector and the MOS transistor for a switch provided between said MOS transistors for amplification to matrix formIt is going to provide the MOS type solid state camera providing the MOS transistor for reset which was connected to the outputting part of said photo detectorand which makes the outputting part of said photo detector constant potential with reset.
[0018]The MOS type solid state camera of this invention

according to Claim 2 as a means for attaining the above-mentioned purposeThe photo detector which generates a signal by photoelectric conversion and is outputtedand the MOS transistor for amplification which amplifies the signalIn the MOS type solid state camera which arranged two or more pixels which have said photo detector and the MOS transistor for a switch provided between said MOS transistors for amplification to matrix formand constituted the picture element partThe substrate of the 1st conduction typeand the 1st field of the 2nd conduction type formed into this substrateBy having the 2nd field of the 1st conduction type formed all over this 1st fieldproviding an opening without said 1st field under said 2nd fieldconstituting said photo detector from said 1st field and said 2nd fieldand changing the potential of said 1st fieldIt is going to provide the MOS type solid state camera having a transistor which resets the output of said photo detector which makes said 2nd field an outputting part.
[0019]The imaging method of the MOS type solid state camera of this invention according to Claim 3 as a means for attaining the above-mentioned purposeIt is an imaging method of the MOS type solid state camera according to claim 1 or 2Set simultaneously the output of said photo detector of said all the pixels as predetermined potentialand the lightwave signal accumulation by said photo detector is startedAfter inputting simultaneously the output of said photo detector of said all the pixels into said transistor for amplification and holding it after specified time elapsethe output of said photo detector is outputted from said transistor for amplification one by one for every line of said picture element partIt is going to provide the imaging method of the carrying-out MOS type solid state camera during the same period simultaneous in lightwave signal accumulation of all the pixels.
[0020]
[Mode for carrying out the invention]Hereafteran embodiment of the invention is described with reference to Drawings. In the following explanationthe same reference mark is given to the same thing as the composition of a conventional exampleand the explanation is omitted.
[0021](The 1st working example) Drawing 1 is an outline block diagram of the MOS type solid state camera by this invention. Drawing 2 is a block diagram showing the pixel in the 1st working example of the MOS type solid state camera by this invention. Drawing 3 is a figure showing the timing of the control signal in the 1st working example of the MOS type solid state camera by this invention.

[0022]The MOS type solid state camera 1 of this invention shown in drawing 1Replace with the address control unit 23 in the MOS type solid state camera 30 of the conventional example mentioned aboveand the address control unit 3It has the MOS type solid state camera and identical configuration of a conventional example except having replaced with the row control equipment 24having replaced the row control equipment 4 with the picture element part 22having replaced the picture element part 2 with the pixel 12and having used the pixel 10. In addition to the controlling signal line outputted from the row control circuit 24the row control circuit 4 has each control line (only henceforth RPD and sound power level) of a RPD line and a sound power level lineand RPD is connected to the pixel 10 of each line in this example. The address control circuit 3 is controlling such a row control circuit 4.
[0023]MOS transistor M8 (M8 is only said hereafter) is newly added to the pixel 10 of the MOS type solid state camera of this invention shown in drawing 2 to the pixel 12 of a conventional example. Hereabout M8the drain is connected to the reference voltage supply line 15the gate is connected to RPDand the source is connected to the N side of photo detector PD.M8 is a transistor for reset which resets PD. In drawing 2G shows a gateS shows a source and D shows a drainrespectively.
[0024]When a function of each MOS transistor is explainedM1 as a switch for a VDD set M2As a switch which sets an output from PDM6 and M7 function as a switch as an object for loads which M3 makes output M5 for M4 to OUT as a switch as an object for the amplifier of potential of SF. Timing of a control signal supplied to the pixel 10 from each control line is shown in drawing 3. Although a thing to the pixel 10 of the 1st line of the picture element part 2 and the pixel 10 of the 2nd line is shown as an examplesame operation is performed also to other lines so that it may mention later. A horizontal axis shows time.
[0025]Hereaftersignal processing from the pixel 10 in this example is explained. FirstRG of all the pixels 10 of the picture element part 2 is made into high potentialand node SF of all the pixels 10 is set to potential of VDD. [M1] Nextthe one [TG of all the pixels 10 is made into high potentialand / M2] after making RG into low voltage and turning off M1. Therebyvoltage proportional to potential of photo detector PD to photo detector PD of all the pixels 10 is transmitted to SF. Thenthe one [RPD of all the pixels 10 is made into high potentialand / M8] after making TG into low voltage and turning off M2. As a resultphoto

detector PD of all the pixels 10 is set to potential of VDD.
[0026]If RPD is made into low voltage and M8 is turned off after photo detector PD is set to VDDall the pixels 10 will start accumulation of a lightwave signal simultaneously from this. That islight enters into photo detector PD of floating of all the pixelsit is generated by carrierand an electric charge is accumulated in the N side of photo detector PD. Since a period of this signal accumulation is controlled to become time until TG of all the pixels 10 becomes high potential simultaneously againlength and time of onset of signal storage time become the same also with all the pixels 10 after all.
[0027]A signal transmitted to all the pixel 10 coincidence at node SF is read one line at a time one by one like a conventional example after that. Since VB has started M5 if one [RS of a pixel of the 1st line serves as high potential at the beginning and / M4]voltage of (voltage proportional to potential of PD) - (threshold voltage of M3) appears in the node OUT. If one [SHS is made into high potential after that and / M6]capacity CS will be charged on this voltage.
[0028]After making SHS into a low voltage and turning off M6if one [RG is made into high potential and / M1]node SF will be set to voltage of VDD and voltage of the node OUT will change to (potential of VDD) - (threshold voltage of M3). One [SHR is made into high potential and / M7] in order to charge capacity CR on this voltage. Since the capacity CS and CR is connected to each input of differential amplifier DAvoltage of (voltage proportional to potential of PD) - (potential of VDD) is obtained as an output of DA.Since this serves as an output which is not related to dispersion in threshold voltage of M3 for every pixel 10there is no fixed pattern noise generated fixed every pixel 10.
[0029]If signal read-out of a pixel of the 1st line is completedin a similar waya signal of a pixel of the 2nd line will be readthis will be repeatedand signal read-out of the 1 field will be performed. As explained abovelightwave signal accumulation which received light at the time same in this example also as all the pixels 10 is startedSince an accumulated lightwave signal is collectively transmitted to node SF and a signal is read from a pixel of every a party to the same time after thatalso when incorporating a photographic subject which moves as Still Picture Sub-Divisiondistortion of a picture is not generated.
[0030]In this examplesince the transistor M8 for reset of

photo detector PD is unrelated to signal read operation of each pixel rowto any timing under signal read-outand it may be turned off. As a resultone of M8 and OFF time can be adjusted and a function of an electronic shutter can be realized. For examplein a case where all the pixels are read in 1/30 secondif it does not reset again during the read-out of all the pixels after resetting a photo detector of all the pixels once at the left end of a timing chart of drawing 3shutter speed is equivalent to 1/30 second. What is necessary is to cancel a lightwave signal which reset a photo detector and was accumulated by then1/1000 second before a read-out period of all the pixels expiresand to read only a lightwave signal collected at the remaining time (for 1/1000 seconds)when realizing shutter speed for 1/1000 secondfor example. If this function is usedit can incorporate as Still Picture Sub-Division without blur also with a photographic subject which moves at high speed.

[0031](The 2nd working example) Drawing 4 is a block diagram showing a pixel in the 2nd working example of an MOS type solid state camera by this invention. The pixel 11 in the MOS type solid state camera 1 of this invention shown in drawing 4Except that it replaces with photo detector PD and the transistor M8 for reset in the pixel 10 of an working example 1 mentioned aboveit changes into the control line RPD of M8 using the vertical mold NPN mold structure transistor T1 and a sound power level line is connected to T1a pixel and an identical configuration of an working example 1 are carried out. In this exampleas row controlthe MOS type solid state camera 1 of an working example is replaced with sound power leveland RPD is used for it.

[0032]Hereit vertical mold NPN mold structure transistor T1 (T1 is only said hereafter) per explains. Drawing 5 is a sectional view of a photo detector in the 2nd working example of an MOS type solid state camera by this invention. In drawing 5P well region and 31 show N type region35 shows P well openingandas for an N type board and 3332 shows a depletion layer 34. A photo detector (it is indicated as PD) is formed by a PN junction of the P well region 33 in an N type boardand the N type region 31 currently formed in it.

[0033]An opening (P well opening 35) without P well is provided in a part of being [it]-under N type region 31 P well region 33. When the N type boards 31 are [power supply voltage and the P well region 33] ground potentialN type region of P well opening 35 all sets up the size W of this P well opening 35 so that it may become a depletion

layer.
[0034]The N type board 32 is connected to the reference voltage power source wire 15 hereand VDD is supplied. The P well region 33 is connected to sound power leveland N type region is connected to the source of M2. When sound power level is ground potentialthe N type region 31 and the N type board 32 are separated by the depletion layer 34 (when it is at the drawing 4 (A) charge storage time)and the optical carrier generated by incidence of light is accumulated in the PN junction of the N type region 31 and the P well region 33.
[0035]On the other handsince the reverse bias of the N type board 32 and the P well region 33 will decrease if sound power level is set as the middle grade of ground potential and the power supply potential VDD (in the case at the time of the drawing 4 (B) reset)The depletion layer 34 in P well opening 35 dissociatesthe N type region 31 and the N type board 32 conductN type region serves as the power supply potential VDDand a photo detector is reset.
[0036]Thereforein this exampleif sound power level is made into predetermined potential instead of replacing with sound power level RPD in the timing chart of drawing 3 explained in the 1st above-mentioned working exampleand making RPD into high potentialit turns out that the same signal drawing as the working example 1 can be performed. Namelyin this exampleall the pixels 11 start the lightwave signal accumulation by light-receiving at the same timeSince the accumulated lightwave signal is collectively transmitted to node SF and the signal is read from the pixel of every a party to the same time after thatalso when incorporating the photographic subject which moves as Still Picture Sub-Divisiondistortion of a picture is not generated.
[0037]In this examplesince the reset action in the transistor T1 which has photo detector PD and a function which resets this is unrelated to the signal read operation of each pixel rowto any timing under signal read-outand it may be turned off. As a resultit is the same as that of the working example 1 that one of T1 and OFF time can be adjusted and the function of an electronic shutter can be realized.
[0038]Although it comprised five MOS transistors per pixeland there were many a MOS transistors and only the part needed to make area of the photo detector smaller than the pixel of the conventional example in the 1st working exampleIn this examplethis point can also be improvedarea of a photo detector can be made equivalent to a

conventional exampleand the fall of sensitivity to light can be suppressed. Although vertical mold NPN transistor T1 was explained to the example aboveit may replace with this and a vertical mold PNP transistor may be used.
[0039]
[Effect of the Invention]As explained abovethe MOS type solid state camera of this invention by Claim 1The photo detector which generates a signal by photoelectric conversion and is outputtedand the MOS transistor for amplification which amplifies the signalIn the MOS type solid state camera which arranged two or more pixels which have said photo detector and the MOS transistor for a switch provided between said MOS transistors for amplification to matrix formBy having provided the MOS transistor for reset which was connected to the outputting part of said photo detector and which makes the outputting part of said photo detector constant potential with resetIt enables it to make the same the length and its storage start time of a signal storage period of a photo detector by all the pixelsAlso when incorporating the photographic subject which moves by this as Still Picture Sub-Divisionit is effective in not producing distortion of a picture and being able to provide the MOS type solid state camera which has electronic shutter functions.
[0040]And it is effective in the ability to provide the MOS type solid state camera which does not complicate composition of a pixel.
[0041]The imaging method of the MOS type solid state camera of this invention according to Claim 3 as explained aboveIt is an imaging method of the MOS type solid state camera according to claim 1 or 2Set simultaneously the output of said photo detector of said all the pixels as predetermined potentialand the lightwave signal accumulation by said photo detector is startedAfter inputting simultaneously the output of said photo detector of said all the pixels into said transistor for amplification and holding it after specified time elapsethe output of said photo detector is outputted from said transistor for amplification one by one for every line of said picture element partLightwave signal accumulation of all the pixels during the same period simultaneous by having been made to carry outIt enables it to make the same the length and its storage start time of a signal storage period of a photo detector by all the pixelsAlso when incorporating the photographic subject which moves by this as Still Picture Sub-Divisionit is effective in not producing distortion of a picture and being able to provide the imaging method of the MOS type

solid state camera which has electronic shutter functions.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an outline block diagram of the MOS type solid state camera by this invention.
[Drawing 2]It is a block diagram showing the pixel in the 1st working example of the MOS type solid state camera by this invention.
[Drawing 3]It is a figure showing the timing of the control signal in the 1st working example of the MOS type solid state camera by this invention.
[Drawing 4]It is a block diagram showing the pixel in the 2nd working example of the MOS type solid state camera by this invention.
[Drawing 5]It is a sectional view of the photo detector in the 2nd working example of the MOS type solid state camera by this invention.
[Drawing 6]It is an outline block diagram of the MOS type solid state camera of a conventional example.
[Drawing 7]It is a block diagram showing the pixel in the MOS type solid state camera of a conventional example.
[Drawing 8]It is a figure showing the timing of the control signal in the MOS type solid state camera of a conventional example.
[Explanations of letters or numerals]
1 [-- Row control circuit] -- An MOS type solid state camera2 -- A picture element part3 -- An address control circuit4 5 [-- Level address selection circuits] -- A row control circuit6 -- A data control circuit7 -- A digital disposal circuit8 10 [-- A reference voltage supply line16 / -- Reference voltage supply line] -- A pixel11 -- A pixel12 -- A pixel15 20 [-- A row control circuit30 / -- An MOS type solid state camera31 / -- N type region32 / -- An N type board33 / -- P well region34 / -- A depletion layer35 / -- P well opening.] -- A signal processing part22 -- A picture element part23 -- An address control circuit24